

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A biometric recognition apparatus characterized by comprising:

a detection element which electrically contacts an object;

a supply signal generating unit which generates an AC supply signal;

a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information to output a detection signal representing the waveform information, said response signal having a voltage level thereof shifted so as to have a center potential substantially equal to that of a reference signal which is synchronized with said supply signal, which voltage level cyclically varies between a positive or negative supply voltage and a ground potential information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body.

2. (Original) A biometric recognition apparatus according to claim 1, characterized in that the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which the apparatus is in contact through said detection element.

3. (Original) A biometric recognition apparatus according to claim 2, characterized in that said waveform information detection unit detects a phase difference between the supply signal and the response signal as the waveform information.

4. (Original) A biometric recognition apparatus according to claim 2, characterized in that said waveform information detection unit detects a detection signal corresponding to an amplitude peak value of the response signal as the waveform information.

5. (Original) A biometric recognition apparatus according to claim 2, characterized in that said waveform information detection unit separately detects waveform information representing a phase of the response signal and waveform information representing an amplitude of the response signal, and said biometric recognition unit determines on the basis of the respective detection signals representing the pieces of waveform information whether or not the object is a living body.

6. (Cancelled)

7. (Currently Amended) A biometric recognition apparatus according to claim ~~6.1~~, wherein the individual parameters comprise a real component and imaginary component of an impedance of the object with which the apparatus is in contact through said detection element, and

~~characterized in that~~ said waveform information detection unit detects a phase difference between the supply signal and the response signal as waveform information representing the imaginary component.

8. (Currently Amended) A biometric recognition apparatus according to claim ~~6.1~~, wherein the individual parameters comprise a real component and imaginary component of an impedance of the object with which the apparatus is in contact through said detection element, and

~~characterized in that~~ said waveform information detection unit detects an amplitude peak value of the response signal as waveform information representing the real component.

9. (Currently Amended) A ~~biometric recognition apparatus according to claim 3~~ A biometric recognition apparatus comprising:

a detection element which electrically contacts an object;
a supply signal generating unit which generates an AC supply signal;
a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply

signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body,

wherein the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which the apparatus is in contact through said detection element,

said waveform information detection unit detects a phase difference between the supply signal and the response signal as the waveform information, and

~~characterized in that~~ said detection element includes a first detection electrode which electrically contacts the object and is connected to a predetermined common potential, and a second detection electrode which electrically contacts the object, said supply signal generating unit includes an offset removing circuit which outputs an AC supply signal as the supply signal from which an offset is removed to make a central potential coincide with the common potential, said response signal generating unit applies the supply signal to the second detection electrode of said detection element, and outputs a signal as a response signal which changes in phase in accordance with the impedance of the object, said waveform information detection unit includes a level shift circuit which

level-shifts the response signal to make a central potential of the response signal coincide with a central potential of a reference signal synchronized with the supply signal, detects, as waveform information of the response signal, a phase difference obtained by comparing a phase of the reference signal with the response signal level-shifted by the level shift circuit, and outputs a detection signal representing the waveform information, and said biometric recognition unit determines on the basis of the waveform information of the detection signal whether or not the object is a living body.

10. (Currently Amended) A biometric recognition apparatus according to claim 3 comprising:

a detection element which electrically contacts an object;

a supply signal generating unit which generates an AC supply signal;

a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body,

wherein the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which the apparatus is in contact through said detection element,

said waveform information detection unit detects a phase difference between the supply signal and the response signal as the waveform information, and

~~characterized in that~~ said detection element includes a first detection electrode which electrically contacts the object and is connected to a predetermined common potential, and a second detection electrode which electrically contacts the object, said response signal generating unit applies the supply signal to the second detection electrode of said detection element, and outputs, as a response signal, a signal whose phase has changed in accordance with the impedance of the object with which the apparatus is in contact through said detection element, said waveform information detection unit includes an offset correction circuit which corrects an offset in the response signal so as to make a central potential of the response signal coincide with a predetermined reference potential used for the phase comparison, and detects, as waveform information of the response signal, a phase difference obtained by comparing a phase of a reference signal synchronized with the supply signal with a phase of the response signal corrected by the offset correction circuit, and said biometric recognition unit determines on the basis of the waveform information of the detection signal whether or not the object is a living body.

11. (Currently Amended) A biometric recognition apparatus ~~according to claim 3~~ comprising:

a detection element which electrically contacts an object;

a supply signal generating unit which generates an AC supply signal;

a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body,

wherein the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which the apparatus is in contact through said detection element,

said waveform information detection unit detects a phase difference between the supply signal and the response signal as the waveform information,

said apparatus characterized by further comprising a reference potential supply unit which supplies a reference potential equal to a central potential of the supply signal to the first detection electrode of said detection element, wherein said detection element includes a first detection electrode which electrically contacts the object and is connected to a predetermined common potential, and a second detection electrode which electrically

contacts the object, said response signal generating unit applies the supply signal to the second detection electrode of said detection element, and outputs, as a response signal, a signal whose phase has changed in accordance with the impedance of the object with which the apparatus is in contact through said detection element, said waveform information detection unit detects, as waveform information of the response signal, a phase difference obtained by comparing a phase of a reference signal synchronized with the supply signal with a phase of the response signal, and said biometric recognition unit determines on the basis of the waveform information of the detection signal whether or not the object is a living body.

12. (Currently Amended) A biometric recognition apparatus according to claim 4 comprising:

a detection element which electrically contacts an object;

a supply signal generating unit which generates an AC supply signal;

a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body,

wherein the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which the apparatus is in contact through said detection element,

wherein said waveform information detection unit detects a phase difference between the supply signal and the response signal as the waveform information, and

~~characterized in that~~ said detection element includes a first detection electrode which electrically contacts the object and is connected to a predetermined common potential, and a second detection electrode which electrically contacts the object, said supply signal generating unit includes an offset removing circuit which outputs an AC supply signal obtained by removing an offset from the supply signal so as to make a central potential of the supply signal coincide with the common potential, said response signal generating unit applies the supply signal to the second detection electrode of said detection element, and outputs, as a response signal, a signal whose amplitude has changed in accordance with the impedance of the object with which the apparatus is in contact through said detection element, said waveform information detection unit includes a maximum voltage detection circuit which detects a maximum voltage value of the response signal as the amplitude, and detects the amplitude obtained by the maximum voltage detection unit as waveform information of the response signal, and said biometric recognition unit determines on the basis of the waveform information of the detection signal whether or not the object is a living body.

13. (Currently Amended) A biometric recognition apparatus according to claim 4 comprising:

a detection element which electrically contacts an object;

a supply signal generating unit which generates an AC supply signal;

a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body,

wherein the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which the apparatus is in contact through said detection element,

said waveform information detection unit detects a phase difference between the supply signal and the response signal as the waveform information, and

characterized in that said detection element includes a first detection electrode which electrically contacts the object and is connected to a predetermined common potential, and a second detection electrode which electrically contacts the object, said

response signal generating unit applies the supply signal to the second detection electrode of said detection element, and outputs, as a response signal, a signal whose amplitude has changed in accordance with the impedance of the object with which the apparatus is in contact through said detection element, said waveform information detection unit includes a peak voltage detection circuit which detects a peak voltage value of the response signal, a central voltage detection circuit which detects a central voltage value of the response signal, and a voltage comparison circuit which detects an amplitude of the response signal by comparing the peak voltage value with the central voltage value, and detects the amplitude detected by the voltage comparison circuit as waveform information of the response signal, and said biometric recognition unit determines on the basis of the waveform information of the detection signal whether or not the object is a living body.

14. (Currently Amended) A biometric recognition apparatus ~~according to claim 4~~ comprising:

a detection element which electrically contacts an object;

a supply signal generating unit which generates an AC supply signal;

a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body,

wherein the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which the apparatus is in contact through said detection element,

said waveform information detection unit detects a phase difference between the supply signal and the response signal as the waveform information, and

~~characterized in that~~ said detection element includes a first detection electrode which electrically contacts the object and is connected to a predetermined common potential, and a second detection electrode which electrically contacts the object, said response signal generating unit applies the supply signal to the second detection electrode of said detection element, and outputs, as a response signal, a signal whose amplitude has changed in accordance with the impedance of the object with which the apparatus is in contact through said detection element, said waveform information detection unit includes a maximum voltage detection circuit which detects a maximum voltage value of the response signal, a minimum detection circuit which detects a minimum voltage value of the response signal, and a voltage comparison circuit which compares the maximum voltage value with the minimum voltage value to detect the amplitude, and detects the amplitude as waveform information of the response signal, and said biometric recognition unit determines on the basis of the waveform information of the detection signal whether

or not the object is a living body.

15. (Original) A biometric recognition apparatus according to claim 1, characterized in that said biometric recognition unit determines whether or not the object is a living body, by comparing a recognition index value obtained from the waveform information of the detection signal with a reference range of a plurality of recognition index value reference values obtained under a plurality of measurement conditions.

16. (Original) A biometric recognition apparatus according to claim 15, characterized in that said biometric recognition unit performs the determination on the basis of a plurality of recognition index values obtained respectively for supply signals having different frequencies generated by said supply signal generating unit.

17. (Original) A biometric recognition apparatus according to claim 15, characterized in that said biometric recognition unit performs the determination on the basis of a plurality of recognition index values obtained respectively for different elapsed times from the start of application of the supply signal.

18. (Original) A biometric recognition apparatus according to claim 15, characterized in that when comparing said each recognition index value with the reference range, said biometric recognition unit uses an individual reference range corresponding to a measurement condition under which each recognition index value is obtained.

19. (Original) A biometric recognition apparatus according to claim 15, characterized in that said waveform information detection unit detects a phase difference between the response signal and a reference signal synchronized with the supply signal as the waveform information.

20. (Original) A biometric recognition apparatus according to claim 15, characterized in that said waveform information detection unit detects an amplitude of the response signal with respect to a reference signal synchronized with the supply signal as the waveform information.

21. (Original) A biometric recognition apparatus according to claim 15, characterized in that said waveform information detection unit detects a phase difference between the response signal and a reference signal synchronized with the supply signal and an amplitude of the response signal as the waveform information.

22. (Original) A biometric recognition apparatus according to claim 2, characterized in that said supply signal generating unit includes a frequency generating circuit which generates a rectangular wave signal having a predetermined frequency, and a waveform shaping circuit which extracts a desired frequency component from the rectangular wave signal generated by said frequency generating circuit as the supply signal, and generates, as the supply signal, a supply signal formed from an AC signal having a predetermined frequency.

23. (Original) A biometric recognition apparatus according to claim 22, characterized in that said waveform shaping circuit includes a low-pass filter which extracts a desired low-frequency component from the rectangular wave signal.

24. (Currently Amended) A biometric recognition apparatus according to claim 22 comprising:

a detection element which electrically contacts an object;

a supply signal generating unit which generates an AC supply signal;

a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body,

wherein the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which the apparatus is in contact through said detection element,

said supply signal generating unit includes a frequency generating circuit which generates a rectangular wave signal having a predetermined frequency, and a waveform shaping circuit which extracts a desired frequency component from the rectangular wave signal generated by said frequency generating circuit as the supply signal, and generates, as the supply signal, a supply signal formed from an AC signal having a predetermined frequency, and

~~characterized in that~~ said waveform shaping circuit includes an amplitude limiting circuit which outputs the rectangular wave signal upon limiting an amplitude thereof, a low-pass filter which extracts a desired low-frequency component from the signal obtained by the amplitude limiting circuit, and an amplification circuit which outputs the signal obtained by the low-pass filter upon amplifying the signal.

25. (Original) A biometric recognition apparatus according to claim 24, characterized in that said amplitude limiting circuit includes a first reference voltage generating circuit which generates a first reference voltage, a second reference voltage generating circuit which generates a second reference voltage, an inverter circuit which outputs the rectangular wave signal upon inverting a logical value of the signal, a first switch element which intermittently outputs the first reference voltage by performing switching operation in accordance with the signal obtained by the inverter circuit, and a second switch element which intermittently outputs the second reference voltage at a timing opposite to that of the first switch element by performing switching operation in accordance with the rectangular wave signal.

26. (Original) A biometric recognition apparatus according to claim 24, characterized in that said amplitude limiting circuit includes a first reference voltage generating circuit which generates a first reference voltage, a second reference voltage generating circuit which generates a second reference voltage, a first switch element which intermittently outputs the first reference voltage by performing switching operation in accordance with the rectangular wave signal, and a second switch element which intermittently outputs the second reference voltage at a timing opposite to that of the first switch element by performing switching operation in a phase opposite to that of the first switch element in accordance with the rectangular wave signal.

27. (Currently Amended) A biometric recognition apparatus ~~according to claim 22, characterized in that comprising:~~

a detection element which electrically contacts an object;

a supply signal generating unit which generates an AC supply signal;

a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body,

wherein the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which the apparatus is in contact through said detection element,

said supply signal generating unit includes a frequency generating circuit which generates a rectangular wave signal having a predetermined frequency, and a waveform shaping circuit which extracts a desired frequency component from the rectangular wave signal generated by said frequency generating circuit as the supply signal, and generates, as the supply signal, a supply signal formed from an AC signal having a predetermined frequency, and

said waveform shaping circuit includes an amplitude limiting low-pass filter which limits an amplitude of the rectangular wave signal and extracts a desired low-frequency component from the rectangular wave signal, and an amplification circuit which amplifies and outputs the signal obtained by the low-pass filter.

28. (Original) A biometric recognition apparatus according to claim 27, characterized in that said amplitude limiting low-pass filter includes a first resistive element having one terminal connected to a first common potential, a second resistive element having one terminal connected to a second common potential, a first switch element which outputs the first common potential through the first resistive element by being connected to the other terminal of the first resistive element and performing switching operation with a predetermined polarity in accordance with the rectangular

wave signal, and a second switch element which intermittently outputs the second common potential through the second resistive element at a timing opposite to that of the first switch element by being connected to the other terminal of the second resistive element and performing switching operation in a phase opposite to that of the first switch element in accordance with the rectangular wave signal.

29. (Original) A biometric recognition apparatus according to claim 27, characterized in that the amplitude limiting low-pass filter includes a first reference voltage generating circuit which generates a first reference voltage, a second reference voltage generating circuit which generates a second reference voltage, a first switch element which performs switching operation upon input of the first reference voltage to a control terminal and input of the rectangular wave signal to an input terminal, and a second switch element which performs switching operation in a phase opposite to that of the first switch element upon input of the second reference voltage to a control terminal and connection of an output terminal of the first switch element to an input terminal.

30. (Original) A biometric recognition apparatus according to claim 22, characterized by further comprising a frequency control unit which outputs a frequency control signal which designates a frequency of the supply signal, wherein said frequency generating circuit outputs a rectangular wave signal having a frequency corresponding to the frequency control signal, and said waveform shaping circuit extracts a frequency component corresponding to the frequency control signal from the rectangular wave signal and outputs the frequency component as the supply signal.

31. (Original) A biometric recognition apparatus according to claim 30, characterized in that said waveform shaping circuit includes a variable low-pass filter which extracts a low-frequency component corresponding to the frequency control signal from the rectangular wave signal.

32. (Currently Amended) A biometric recognition apparatus according to claim ~~31~~ comprising:

a detection element which electrically contacts an object;

a supply signal generating unit which generates an AC supply signal;

a response signal generating unit which includes a resistive element connected between said supply signal generating unit and said detection element, applies the supply signal to said detection element through the resistive element, extracts, from one terminal of the resistive element, a response signal containing not less than one individual parameter which changes depending on whether or not the object is a living body, and outputs the signal;

a waveform information detection unit which detects from said response signal at least one of the individual parameters as waveform information from the response signal, and outputs a detection signal representing the waveform information; and

a biometric recognition unit which determines on the basis of the detection signal whether or not the object is a living body,

wherein the individual parameters comprise a phase and amplitude of the response signal which change in accordance with an impedance of the object with which

the apparatus is in contact through said detection element,

said supply signal generating unit includes a frequency generating circuit which generates a rectangular wave signal having a predetermined frequency, and a waveform shaping circuit which extracts a desired frequency component from the rectangular wave signal generated by said frequency generating circuit as the supply signal, and generates, as the supply signal, a supply signal formed from an AC signal having a predetermined frequency,

said apparatus further comprising a frequency control unit which outputs a frequency control signal which designates a frequency of the supply signal, wherein said frequency generating circuit outputs a rectangular wave signal having a frequency corresponding to the frequency control signal, and said waveform shaping circuit extracts a frequency component corresponding to the frequency control signal from the rectangular wave signal and outputs the frequency component as the supply signal,

characterized in that wherein said variable low-pass filter includes a variable resistive element which changes a resistance value in accordance with the frequency control signal upon input of the rectangular wave signal to one terminal, and a variable capacitive element which changes a capacitance value in accordance with the frequency control signal upon being connected between the other terminal of the variable resistive element and a predetermined low impedance potential.